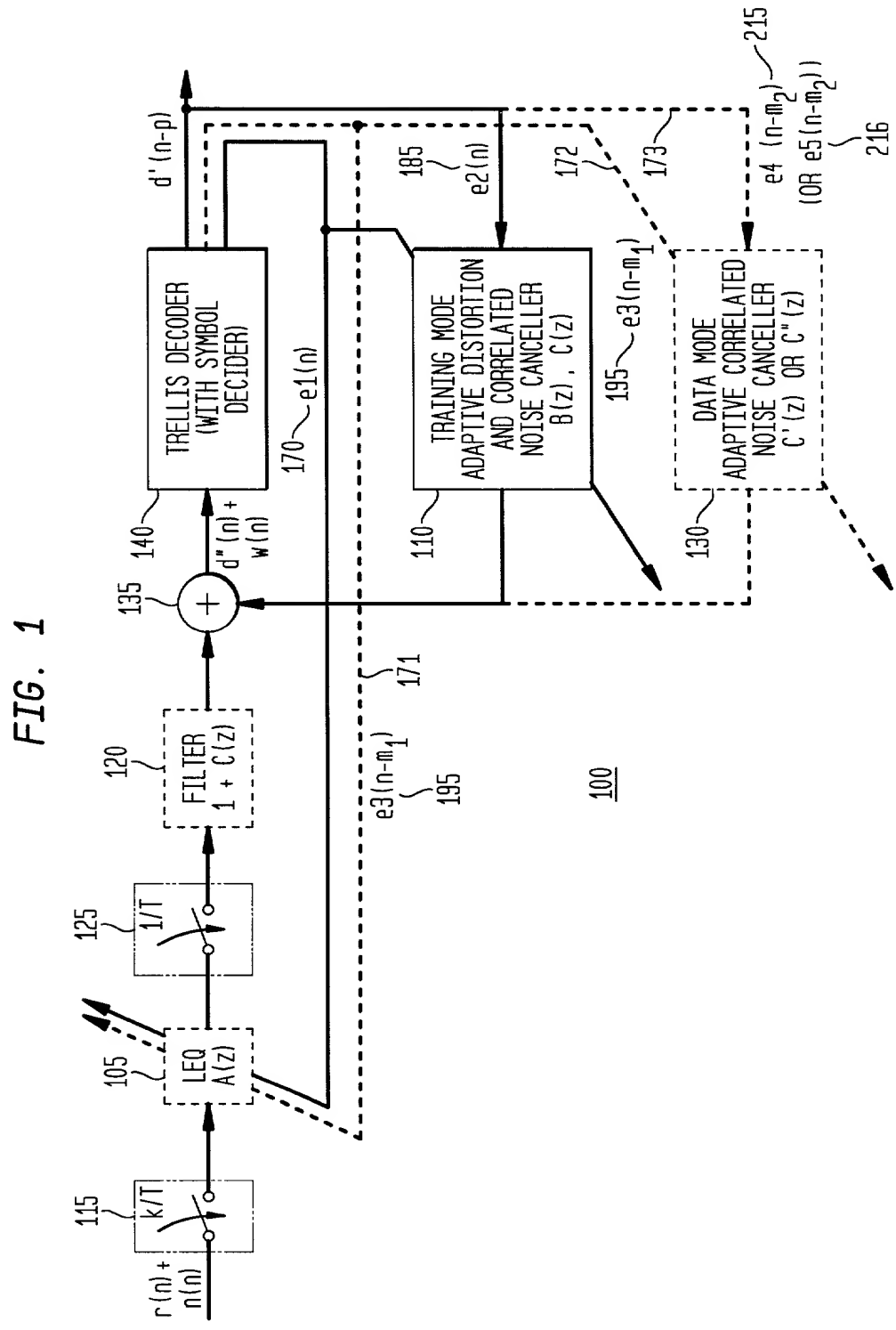

r(n)+ n(n)
115
k/T
105
LEQ A(z)
125
1/T
120
FILTER 1 + C(z)
135
d"(n)+ w(n)
140
TRELLIS DECODER (WITH SYMBOL DECIDER)
d'(n-p)
170
e1(n)
171
e3(n-m1)
195
110
TRAINING MODE ADAPTIVE DISTORTION AND CORRELATED NOISE CANCELLER B(z), C(z)
185
e2(n)
172
173
195
e3(n-m1)
130
DATA MODE ADAPTIVE CORRELATED NOISE CANCELLER C'(z) OR C"(z)
215
e4 (n-m2)
(OR e5(n-m2))
216
100

FIG. 1

FIG. 2

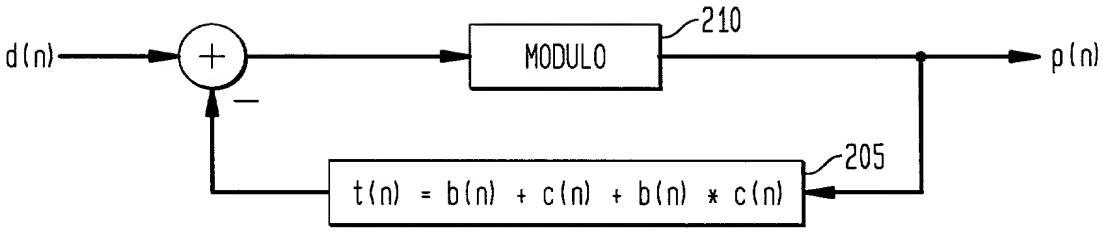
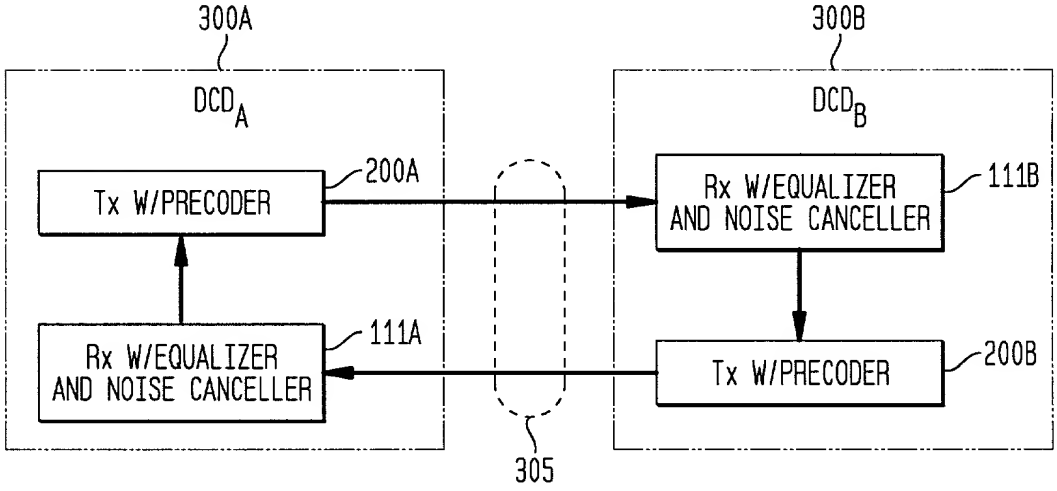

d(n)
+
−
MODULO
210
p(n)
t(n) = b(n) + c(n) + b(n) * c(n)
205
200

FIG. 3


300A
DCD A
Tx W/PRECODER
200A
Rx W/EQUALIZER AND NOISE CANCELLER
111A
300B
DCD B
Rx W/EQUALIZER AND NOISE CANCELLER
111B
Tx W/PRECODER
200B
305

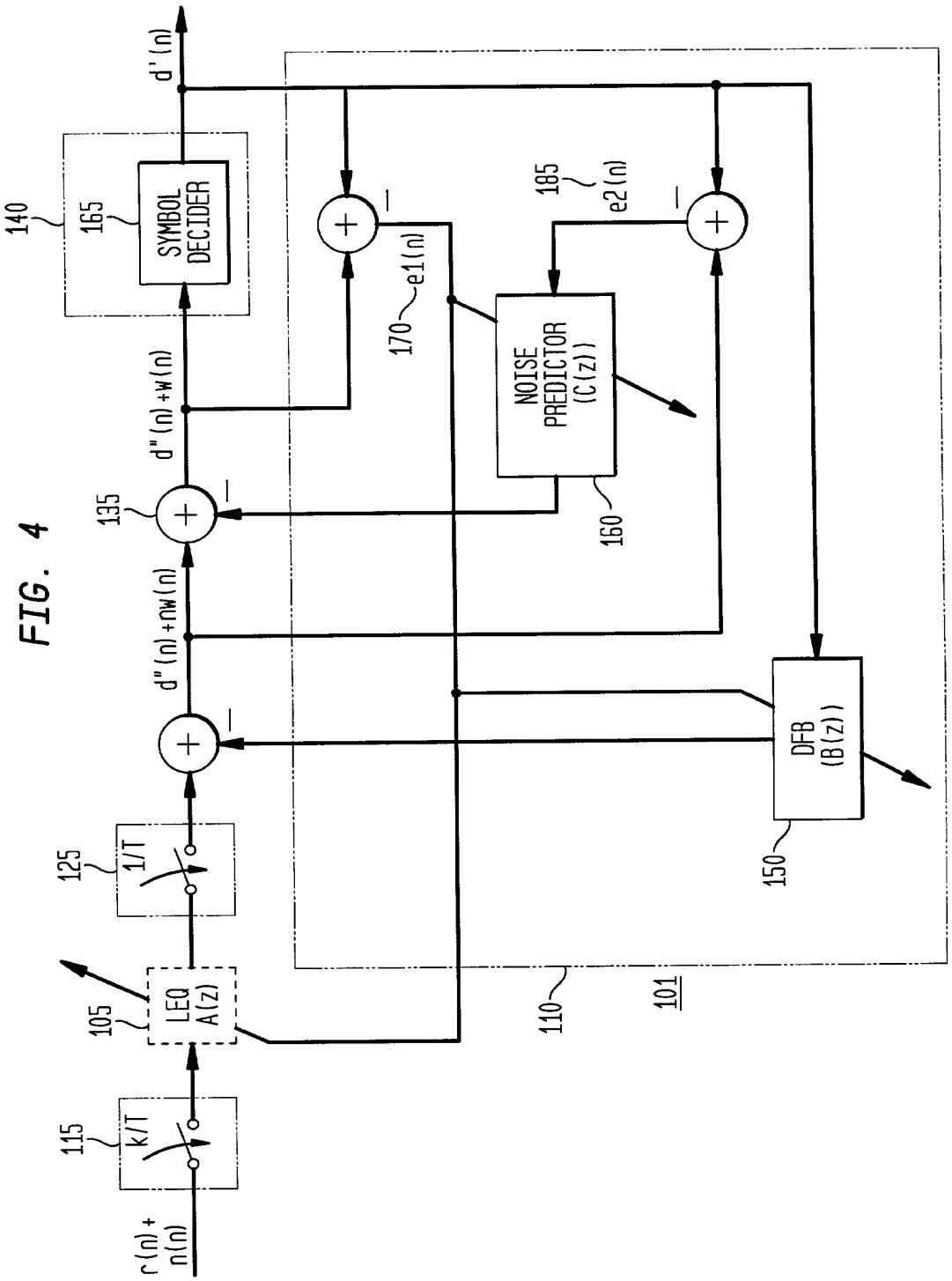

r(n)+
n(n)
115
k/T
105
LEQ
A(z)
125
1/T
d''(n)+nw(n)
135
d''(n)+w(n)
140
165
SYMBOL
DECIDER
d'(n)
110
101
170
e1(n)
185
e2(n)
NOISE
PREDICTOR
(C(z))
160
DFB
(B(z))
150

FIG. 4

FIG. 5

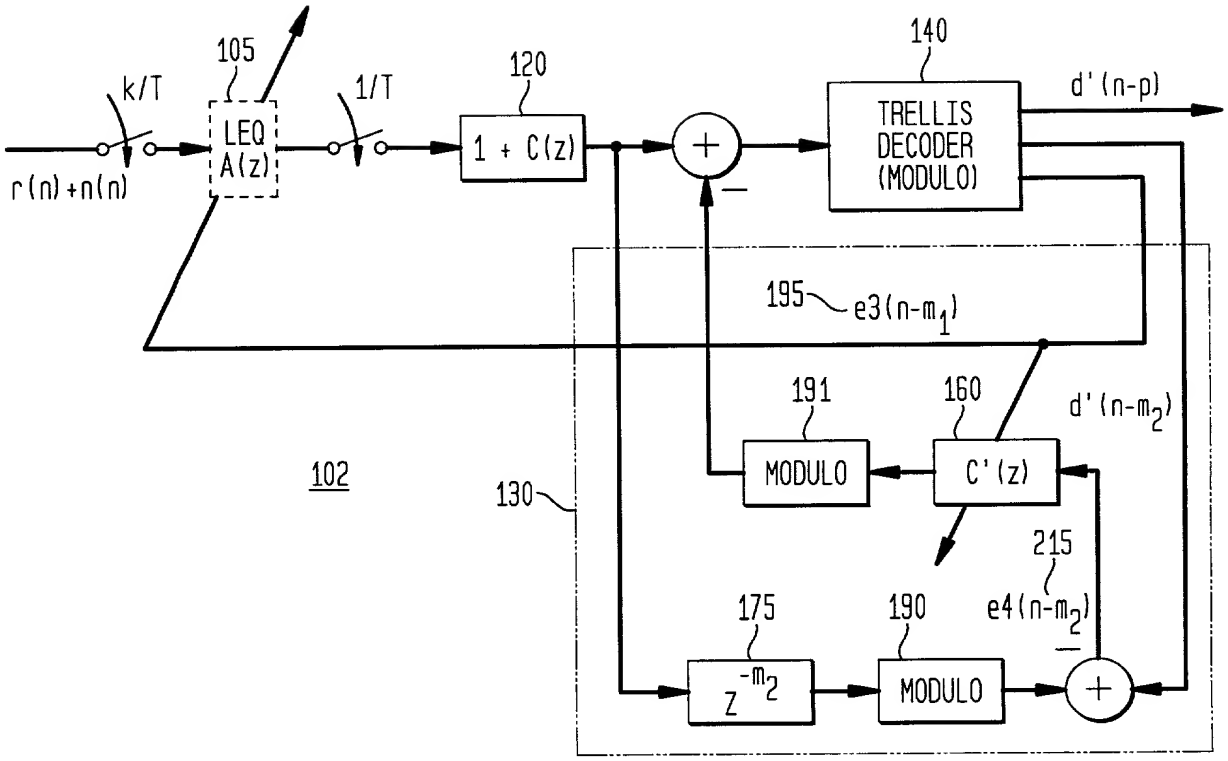

105
k/T
LEQ
A(z)
1/T
r(n)+n(n)
120
1 + C(z)
140
TRELLIS
DECODER
(MODULO)
d'(n-p)
195
e3(n-m1)
191
160
d'(n-m2)
MODULO
C'(z)
102
130
215
175
190
e4(n-m2)
z-m2
MODULO

FIG. 6

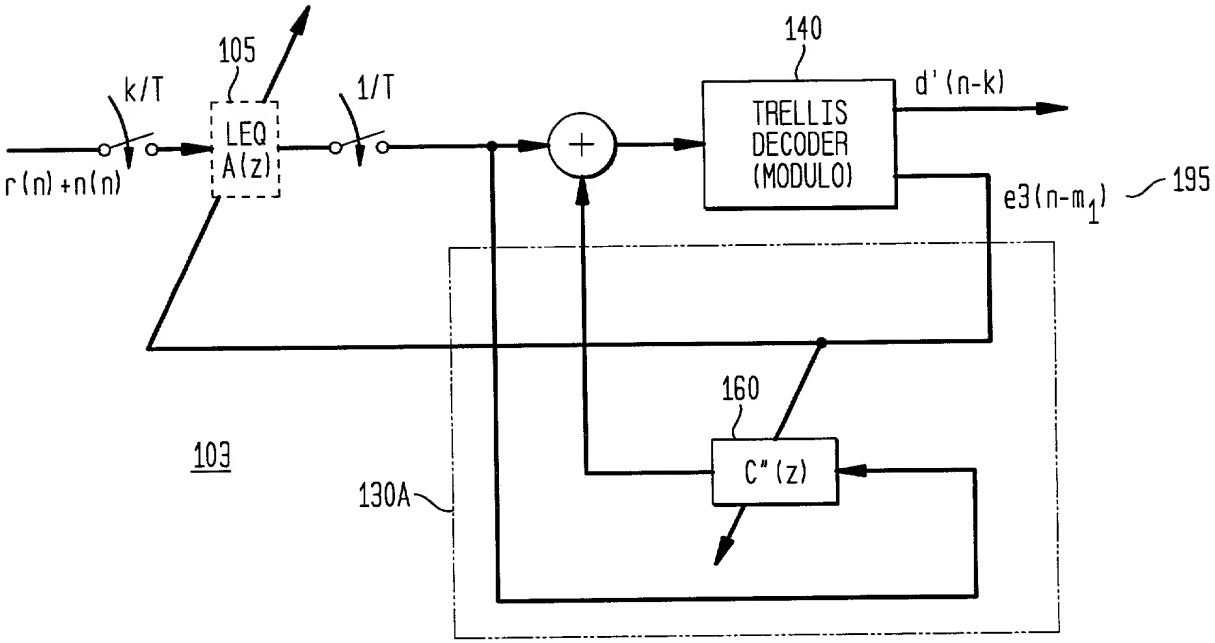

105
k/T
1/T
LEQ
A(z)
r(n)+n(n)
140
TRELLIS
DECODER
(MODULO)
d'(n-k)
e3(n-m1)
195
160
C"(z)
103
130A

FIG. 7

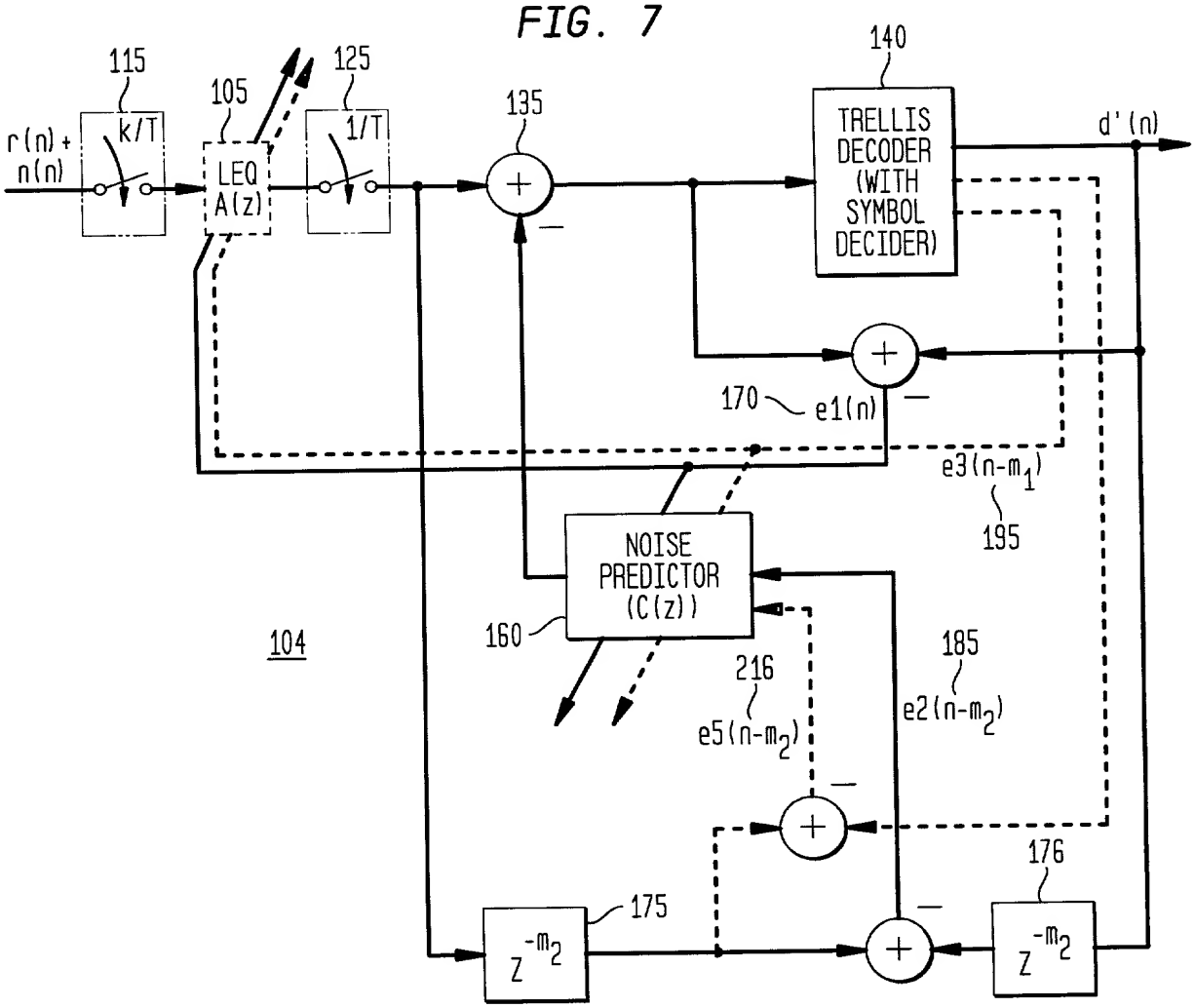

115
105
125
135
140
r(n) + n(n)
k/T
LEQ A(z)
1/T
TRELLIS DECODER (WITH SYMBOL DECIDER)
d'(n)
170
e1(n)
e3(n-m1)
195
NOISE PREDICTOR (C(z))
160
104
216
e5(n-m2)
185
e2(n-m2)
176
175
Z-m2
Z-m2

FIG. 8

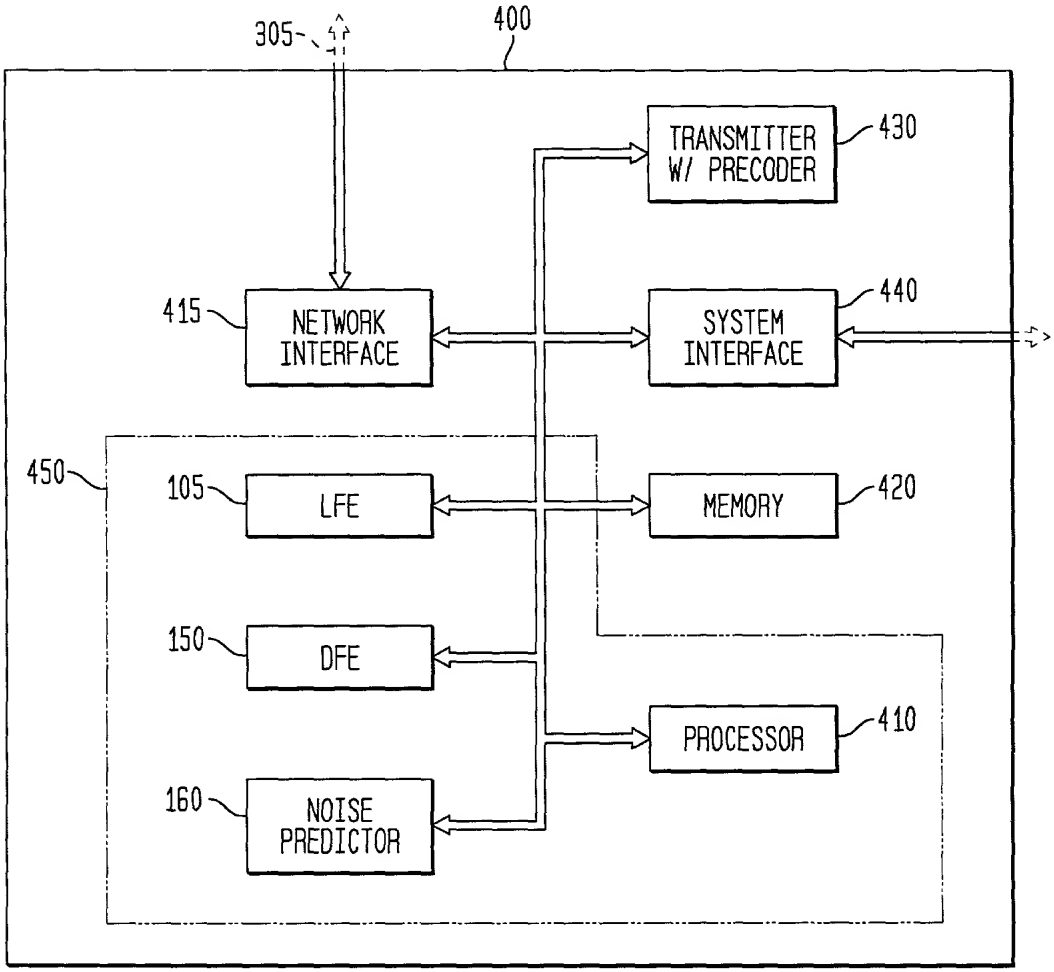

305
400
TRANSMITTER W/ PRECODER
430
415
NETWORK INTERFACE
SYSTEM INTERFACE
440
450
105
LFE
MEMORY
420
150
DFE
PROCESSOR
410
160
NOISE PREDICTOR

FIG. 9

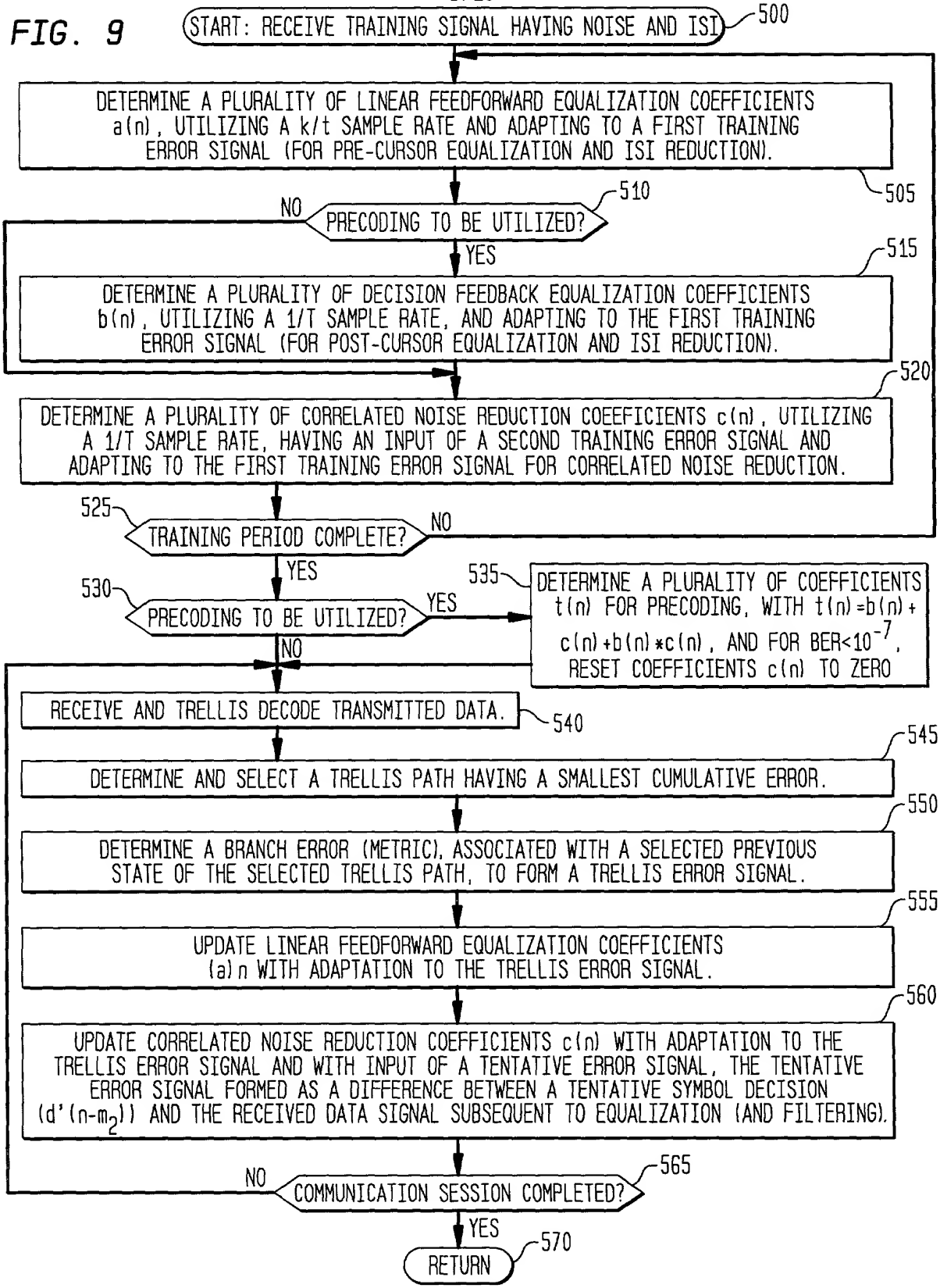

START: RECEIVE TRAINING SIGNAL HAVING NOISE AND ISI
500
DETERMINE A PLURALITY OF LINEAR FEEDFORWARD EQUALIZATION COEFFICIENTS a(n), UTILIZING A k/t SAMPLE RATE AND ADAPTING TO A FIRST TRAINING ERROR SIGNAL (FOR PRE-CURSOR EQUALIZATION AND ISI REDUCTION).
505
PRECODING TO BE UTILIZED?
510
NO
YES
DETERMINE A PLURALITY OF DECISION FEEDBACK EQUALIZATION COEFFICIENTS b(n), UTILIZING A 1/T SAMPLE RATE, AND ADAPTING TO THE FIRST TRAINING ERROR SIGNAL (FOR POST-CURSOR EQUALIZATION AND ISI REDUCTION).
515
DETERMINE A PLURALITY OF CORRELATED NOISE REDUCTION COEEFICIENTS c(n), UTILIZING A 1/T SAMPLE RATE, HAVING AN INPUT OF A SECOND TRAINING ERROR SIGNAL AND ADAPTING TO THE FIRST TRAINING ERROR SIGNAL FOR CORRELATED NOISE REDUCTION.
520
TRAINING PERIOD COMPLETE?
525
NO
YES
PRECODING TO BE UTILIZED?
530
YES
NO
DETERMINE A PLURALITY OF COEFFICIENTS t(n) FOR PRECODING, WITH t(n)=b(n)+c(n)+b(n)*c(n), AND FOR BER<10^-7, RESET COEFFICIENTS c(n) TO ZERO
535
RECEIVE AND TRELLIS DECODE TRANSMITTED DATA.
540
DETERMINE AND SELECT A TRELLIS PATH HAVING A SMALLEST CUMULATIVE ERROR.
545
DETERMINE A BRANCH ERROR (METRIC), ASSOCIATED WITH A SELECTED PREVIOUS STATE OF THE SELECTED TRELLIS PATH, TO FORM A TRELLIS ERROR SIGNAL.
550
UPDATE LINEAR FEEDFORWARD EQUALIZATION COEFFICIENTS (a)n WITH ADAPTATION TO THE TRELLIS ERROR SIGNAL.
555
UPDATE CORRELATED NOISE REDUCTION COEFFICIENTS c(n) WITH ADAPTATION TO THE TRELLIS ERROR SIGNAL AND WITH INPUT OF A TENTATIVE ERROR SIGNAL, THE TENTATIVE ERROR SIGNAL FORMED AS A DIFFERENCE BETWEEN A TENTATIVE SYMBOL DECISION (d'(n-m2)) AND THE RECEIVED DATA SIGNAL SUBSEQUENT TO EQUALIZATION (AND FILTERING).
560
COMMUNICATION SESSION COMPLETED?
565
NO
YES
RETURN
570

FIG. 10

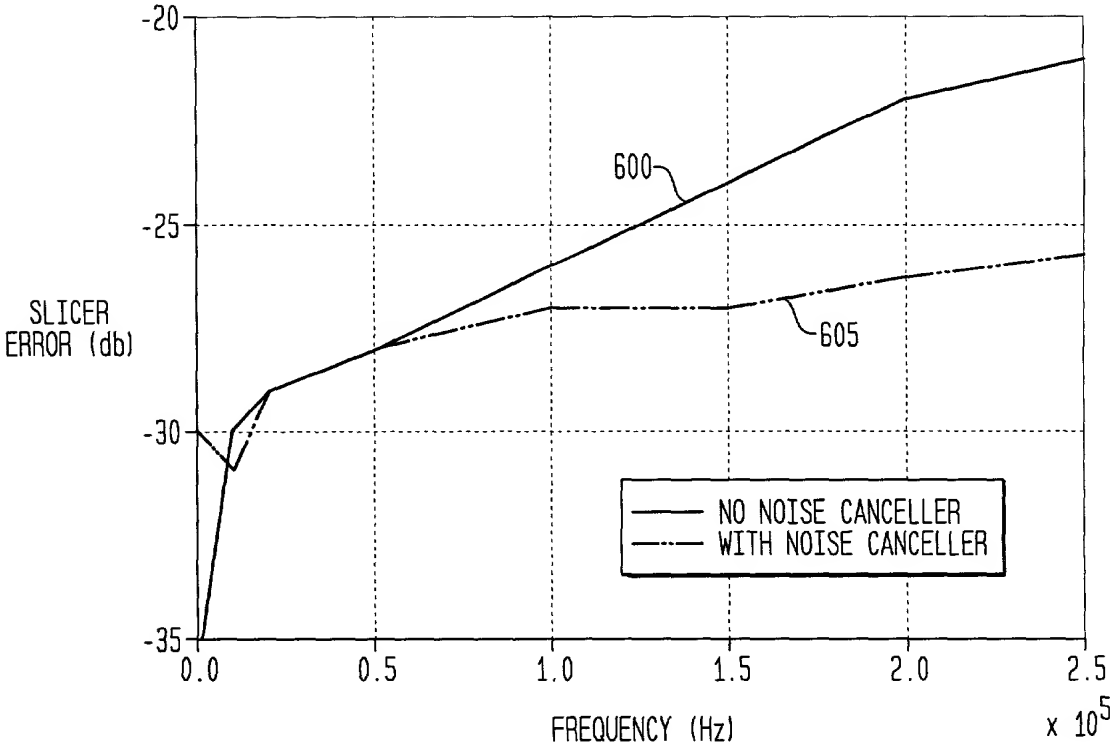

-20
-25
-30
-35
SLICER
ERROR (db)
600
605
NO NOISE CANCELLER
WITH NOISE CANCELLER
0.0
0.5
1.0
1.5
2.0
2.5
FREQUENCY (Hz)
x 10^5

FIG. 11

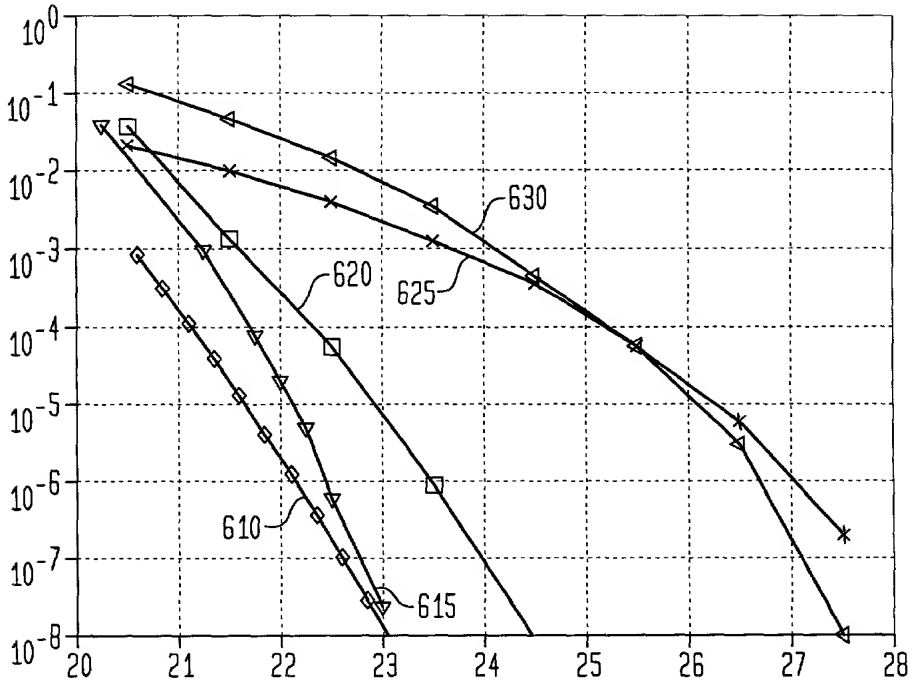

10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
630
620
625
610
615
20
21
22
23
24
25
26
27
28

FIG. 12

720 CROSSTALK ENVIRONMENT	CORRELATION CANCELLER IMPROVED PERFORMANCE MARGIN (db) 735
700 24T1+24 HDSL2(C)	1.4
705 39 HDSL2(C)	1.5
710 24 ADSL+24 HDSL(C)	1.8
715 24 T1+24 HDSL2(R)	1.4